



A Study of the Impact of Digital Transformation on the Stability of Banks

Dan Shi, Hong Rao*

School of Economics, Wuhan University of Technology, Wuhan, China

523248465@qq.com, *1182963061@qq.com

Abstract. This paper aims to quantify the level of digital transformation of commercial banks by big data mining and employ a multiple linear regression statistical model to verify the correlation between digital transformation and the stability of banks. By analyzing the unbalanced panel data of 42 Chinese listed commercial banks from 2013 to 2021, we found that the digital transformation of commercial banks can improve the stability of banks significantly, and this conclusion remains valid after considering potential endogenous problems. Capital regulation can enhance the impact of digital transformation on commercial bank stability.

Keywords: Digital Transformation, Commercial Bank, Stability.

1 Introduction

In recent years, emerging digital technologies have developed rapidly and been widely used in various industries, driving society into a new era characterized by "digital." The integration of digital technology and financial products has changed traditional financial services. For example, it has changed the pattern of payment, lending ecosystem, and wealth management products. Digital technologies have brought many benefits, such as efficiency and convenience, as well as significant challenges to commercial banks. Fintech enterprises compete with commercial banks in the financial sector, forcing banks to improve customer service capabilities and competitiveness by digital transformation (Cappa et al., 2021)^[1]. Studies have shown that digital transformation enhances bank performance mainly by reducing costs and expanding customer coverage (Fuster et al., 2019)^[2]; however, how it affects banks' soundness remains unclear.

Theoretically, digital transformation can affect the stability of commercial banks in two ways. On the one hand, commercial banks can improve their ability to acquire and process data through digital transformation (Huang et al., 2018.)^[3], which can alleviate the problem of information asymmetry between banks and customers, improve the risk control ability of commercial banks, and improve the efficiency of commercial banks (Fuster et al., 2019)^[2], which will be conducive to the stability of banks. On the other hand, digital transformation involves substantial costs, and commercial banks also face technical and regulatory risks, which will undoubtedly harm the stability of commercial

banks. Therefore, studying the impact of digital transformation on the stability of commercial banks is very meaningful.

The innovations of this paper are two folds: Firstly, we measure the digital transformation level of China's banks by text mining technology, providing a valuable reference for studying the banks' digital transformation degree; Secondly, from the micro perspective of banks, we reveal the influencing mechanism of digital transformation on the stability of commercial banks and enriches the research related to the digital transformation of banks.

2 Data and Methodology

2.1 Data sources

This study obtains data from annual reports of commercial banks and the National Bureau of Statistics from 2013 to 2021. In order to ensure the reliability of the results, only banks with at least five years' available annual reports from 2013 to 2021 were selected. A total of 42 banks were selected in this paper.

2.2 Data description

Dependent variable

We use the widely used Zscore as a proxy for the stability of commercial banks (Laeven & Levine, 2009)^[4]. The larger the Zscore value is, the more stable the commercial bank is. The specific calculation method of Zscore is shown in Equation (1).

$$Zscore = \frac{ROA+ETA}{\sigma(ROA)} \quad (1)$$

ROA , ETA , and $\sigma(ROA)$ donate the bank's return on asset, Equity to Asset, and the standard deviation of ROA , respectively.

In the robustness check, we also use the ratio of non-performing loans to gross loans (NPL) as a proxy for the stability of commercial banks (Bian & Deng, 2017; Kim et al., 2016)^{[5][6]}.

Independent variable

Digital transformation is a process by which banks use digital technologies to financial products, organizations, and business strategies (Xie et al., 2023)^[7]. Therefore, we measure the digital transformation of commercial banks from three aspects: digital technology application, digital products, and digital organization. In the dimension of digital technology application, referring to the practice of Zhao et al. (2021)^[8], we count the word frequencies of "digital," "electronic," "intelligent," "big data," "blockchain" in the annual reports of commercial banks. The higher the frequency, the more banks attach importance to digital technology, and the higher the level of digital transformation (Xie et al., 2023)^[7]. After obtaining the word frequency of the keywords, we

use principal component analysis to synthesize the digital technology application index. In the dimension of digital products, we obtain the relevant information on whether commercial banks have launched robot advice, supply chain finance, e-banking, and online loan products from the annual reports of commercial banks and their official website. In the dimension of digital organization, we obtain the following information from the annual report of commercial banks and web crawler technology: whether to set up departments related to the digital transformation of commercial banks, whether to cooperate with Internet enterprises, whether to have directors, supervisors, and senior personnel with an information technology background.

Based on the above three dimensions, we use the principal component analysis method to determine the weight of each sub-index in the comprehensive index and, on this basis, construct the comprehensive index of the digital transformation of commercial banks.

2.3 Moderate variable

This paper uses capital regulation as a moderator variable, and We refer to the practice of Jiang et al. (2017)^[9] to construct the index of capital regulatory pressure faced by banks, as shown in equation (2).

$$CR = \begin{cases} 1/CAR^* - 1/CAR, & CAR > CAR^* \\ 0, & CAR \leq CAR^* \end{cases} \tag{2}$$

where CR, CAR, and CAR* represent the capital regulatory pressure faced by the bank, the actual capital adequacy ratio of the bank, and the minimum capital adequacy ratio required by the regulation, respectively.

2.4 Control variables

This paper adds control variables which might have impact on the stability of banks to improve the research accuracy. We include the bank's lever ratio (LEV), non-interest income ratio (NIIR), return on equity (ROE), gross loan growth rate (LGR), and gross deposit growth rate (DGR). In addition, we also control some macroeconomic variables, such as M2 growth rate (M2), inflation rate (CPI), and GDP growth rate (GDP). The descriptions of the variables are listed in Table 1, and the variable statistics are listed in Table 2.

Table 1. Variable description

Variable	Description
Zscore	The ratio of the sum of the equity ratio and the ratio of return on assets to the standard deviation of the ratio of return on assets
DT	Measurement of digital transformation degree by big data mining from the annual report and official website
CR	The inverse of the regulatory minimum capital adequacy ratio minus the inverse of the bank's actual adequacy ratio

LEV	Equity capital to total assets ratio
NIIR	non-interest income divided by total income
ROE	Net income divided by total equity
LGR	The gross loan growth rate
DGR	The gross deposit growth rate
M2	Broad money growth rate
CPI	Consumer price index
GDP	GDP growth rate

Table 2. Summary statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Zscore	369	5.003	0.795	3.132	8.079
DT	369	92.041	38.838	0	184.387
CR	369	0.025	0.007	0.008	0.051
LEV	369	0.072	0.011	0.042	0.103
NIIR	369	0.203	0.102	0.146	0.511
ROE	369	0.136	0.039	0.056	0.263
LGR	369	0.162	0.067	0.014	0.464
DGR	369	0.127	0.076	-0.064	0.453
M2	369	0.104	0.205	0.081	0.136
CPI	369	0.020	0.006	0.009	0.029
GDP	369	0.066	0.017	0.022	0.0884

2.5 Modeling Specification

Considering the previously theoretical and empirical studies, we specify the multiple linear regression statistical model as equation (3). To investigate the moderating effect of capital regulation on the influence of digital transformation on banks' stability, we specify the following model as equation (4).

$$Zscore_{it} = \alpha_0 + \alpha_1 DT_{it} + \alpha_2 BS_{it} + \alpha_3 MS_t + \delta_i + \theta_t + \varepsilon_{it} \quad (3)$$

$$Zscore_{it} = \alpha_0 + \alpha_1 DT_{it} + \alpha_2 CR_{it} + \alpha_3 DT_{it} \times CR_{it} + \alpha_4 BS_{it} + \alpha_5 MS_t + \delta_i + \theta_t + \varepsilon_{it} \quad (4)$$

where i and t denote the bank and year, respectively. $Zscore_{it}$ is a proxy for the stability of bank i at t period, DT_{it} denotes the degree of digital transformation of bank i at t period, CR represents capital regulatory pressure faced by banks, BS denotes bank-specific control variables, and MS denotes macroeconomic variables. Finally, δ_i and θ_t are the bank and year fixed effect, respectively, ε_{it} is the residual error.

3 Empirical Results

3.1 The benchmark regression result

Before the regression, we conduct the Hausman test to determine whether the random or fixed effect models should be used. The p-value of the Hausman test is 0.0000, which rejects the null hypothesis of the random effect model. Therefore, we use the fixed effect model. Table 3 shows the regression result of equation (1), which explores the relationship between digital transformation and the stability of commercial banks. Column 1 shows the results without adding control variables, and Column 2 represents the regression results with control variables. The coefficients of digital transformation (DT) are all positive and significant at the level of 1%, suggesting that digital transformation might improve the soundness of banks. We employ the non-performing loans ratio (NPL) as a proxy for the bank’s risk to add robustness and credibility to our findings. Column 3 shows the regression results for which the explained variable is NPL. The coefficient of digital transformation (DT) is negatively significant at the level of 1% when we replace the dependent variable with NPL, which shows that our findings are robust.

Table 3. Impact of digital transformation on the stability of banks

	Zscore (1)	Zscore (2)	NPL (3)
DT	0.0070*** (6.85)	0.0099*** (3.09)	-0.0033*** (-3.55)
Control Variables	No	Yes	Yes
_cons		0.8699 (0.86)	3.0793*** (8.11)
Bank fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Obs.	369	369	369
Adj. R2	0.7364	0.8136	0.7941

3.2 Endogeneity concerns

Considering that the digital transformation of commercial banks may be a rational choice made by managers to improve their stability, there may be a bidirectional causal relationship between digital transformation and the stability of commercial banks, which may lead to severe endogeneity problems. We use the fintech development level (FT) of the city where the headquarters of commercial banks are located as the instrumental variable for the digital transformation of commercial banks. On the one hand, the fintech development level where the headquarters of commercial banks are located has a technology spillover effect, which correlates with the digital transformation of commercial banks and meets the correlation requirements of instrumental variables. On the other hand, the fintech development level of the city where the headquarters of

commercial banks are located will not directly impact the robustness of commercial banks, which is in line with the exogeneity requirement of instrumental variables. This paper refers to the practice of Li et al. (2020)^[10] to construct regional fintech indicators.

Table 4 represents the regression results of the second stage using the instrumental variable. We could find that even after controlling for endogeneity issues, digital transformation can still promote the stability of banks.

Table 4. Result of using instrumental variables

	DT (1)	Zscore (2)
DT		0.0186*** (6.11)
FT	19.5296*** (10.77)	
Control Variables	Yes	Yes
Bank fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Obs.	369	369
Adj. R2	0.8231	0.8352
F-statistic	72.34	

3.3 The moderating effect of capital regulation

We employ Equation (4) to test the moderating effect of capital regulation on the influence of digital transformation on the stability of commercial banks. As shown in Table 5, the coefficient of the interaction term of capital regulation (CR) and digital transformation (DT) is significantly positive, indicating that financial regulation can enhance the promotion effect of digital transformation on the stability of banks.

Table 5. The moderating effect of capital regulation on the impact of digital transformation on the stability of commercial banks

	DT (1)
DT	0.0041*** (3.01)
CR	41.2470*** (8.21)
DT×CR	0.2729** (2.04)
Control Variables	Yes
Bank fixed effect	Yes
Year fixed effect	Yes
Obs.	369
Adj. R2	0.8332

4 Conclusions

This paper systematically analyzes the relationship between digital transformation and commercial banks' stability. Using unbalanced panel data of 42 listed banks from 2013 to 2021 for empirical testing, we find that digital transformation has can positively effect on the soundness of commercial banks, and this conclusion is still valid after dealing with the potential endogenous problem. Capital regulation can enhance the impact of digital transformation on commercial bank stability.

References

1. Cappa F, Oriani R, Peruffo E, et al. Big Data for Creating and Capturing Value in the. Digitalized Environment: Unpacking the Effects of Volume, Variety and Veracity on Firm Performance[J]. *Journal of Product Innovation Management*, 2020.
2. Fuster, Andreas, Plosser et al. The Role of Technology in Mortgage Lending[J]. *The. review of financial studies*, 2019.
3. Huang, Y., C. Lin, Z. Sheng, L. Wei. FinTech Credit and Service Quality. BIS Working. Paper, 2018.
4. Laeven L, Levine R. Bank governance, regulation and risk taking[J]. *Journal of Financial. Economics*, 2009, 93(2):259-275.
5. Bian W, Deng C. Ownership dispersion and bank performance: Evidence from. China[J]. *Finance Research Letters*, 2017.
6. Kim H, Park K, Song S. Banking Market Size Structure and Financial Stability: Evidence from Eight Asian Countries[J]. *Emerging Markets Finance and Trade*, 2016.
7. Xie, X., Wang, S., 2023. Digital transformation of commercial banks in China: measurement, progress and impact. *China Econ. Q. Int.* 3, 35–45.
8. Zhao, C., Wang W., Li, Xue. How digital transformation affects total factor productivity of enterprises. *Finance & Trade Economics*, 2021, 42 (07): 114-129.
9. Jiang H, Yang L. Regulatory pressure, market competitiveness and bank soundness: an empirical analysis based on 48 Chinese commercial banks [J]. *Journal of Guangdong University of Finance and Economics*, 2017, 32(03):45-56.
10. Li C., Yan X, Song M. Financial innovation, technology and enterprises new three board. listed company evidence [J]. *China industrial economy*, 2020, (01): 81-98.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

